LAKE ASSESSMENT REPORT FOR LAKE GEORGE IN HILLSBOROUGH COUNTY FLORIDA

Date Assessed: June 15, 2006
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Reviewed by: Jim Griffin

INTRODUCTION

This assessment was conducted to update existing physical and ecological data for Lake George on the Hillsborough County Watershed Atlas (**http://www.hillsborough.wateratlas.usf.edu/**). The project is a collaborative effort between the University of South Florida's Center for Community Design and Research and Hillsborough County Stormwater Management Section. The project is funded by Hillsborough County and the Southwest Florida Water Management District's Northwest Hillsborough, Hillsborough River and Alafia River Basin Boards. The project has, as its primary goal, the rapid assessing of up to 150 lakes in Hillsborough County during a five year period. The product of these investigations will provide the County, lake property owners, and the general public a better understanding of the general health of Hillsborough County lakes, in terms of shoreline development, water quality, lake morphology (bottom contour, volume, area etc.) and the plant biomass and species diversity. These data are intended to assist the County and its citizens to better manage lakes and lake centered watersheds

Figure 1. General Photo of Lake George (6/15/2006).

The first section of the report provides the results of the overall morphological assessment of the lake. Primary data products include: a contour (bathymetric) map of the lake, area, volume and depth statistics, and the water level at the time of assessment. These data are useful for evaluating trends and for the development of management actions such as plant management where depth and lake volume are needed.

The second section provides the results of the vegetation assessment conducted on the lake. These results can be used to better understand and manage vegetation in your lake. A list is provided with the different plant species found at various sites around the lake. Potentially invasive, exotic (non-native) species are identified in a plant list and the total non-native is presented in a summary table. Watershed values provide a means of reference and are derived from the lakes assessed during the 2006 lake assessment project in that watershed.

The third section provides the results of the water quality sampling of the lake. Both field data and laboratory data are presented. The trophic state index (TSI) [i] is used to develop a general lake health statement, which is calculated for both the water column with vegetation and the water column if vegetation were removed (adjusted TSI – Adj_TSI). These data are a combination of the water chemistry and vegetative submerged biomass assessments and are useful in understanding the results of certain lake vegetation management practices.

The intent of this assessment is to provide a starting point from which to track changes in your lake, and where previous comprehensive assessment data is available, to track changes in the lake's general health. These data can provide the information needed to determine changes and to monitor trends in physical condition and ecological health of the lake.

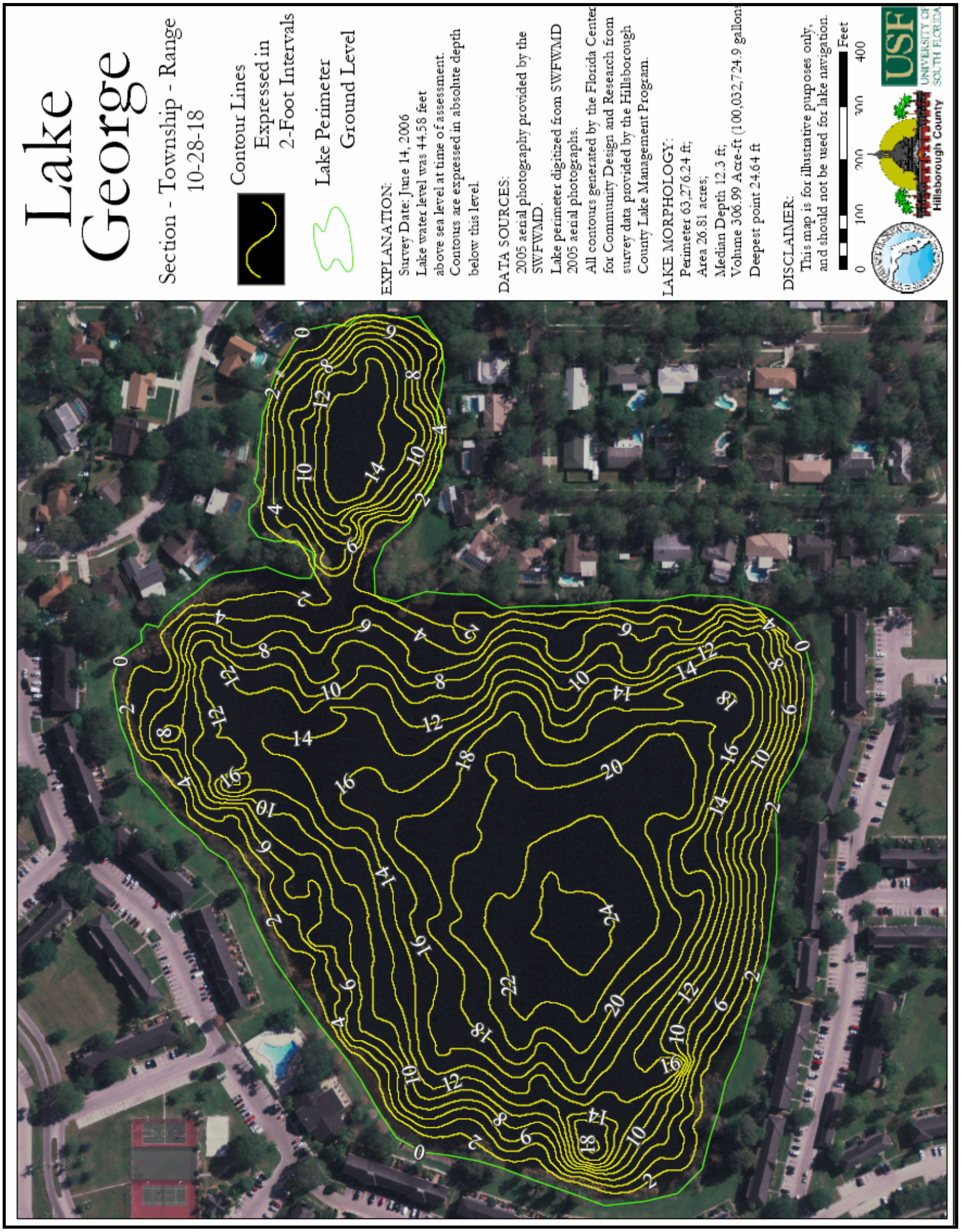
Section 1: Lake Morphology

Bathymetric Map[ii]. The bottom of the lake was mapped using a Lowrance LCX 26C HD Wide Area Augmentation System (WAAS)[iii] enabled Global Positioning System (WAAS-GPS) with fathometer (bottom sounder) to determine the boat's position, and bottom depth in a single measurement. The result is an estimate of the lake's area, mean and maximum depths, and volume and the creation of a bottom contour map (Figure 2). Besides pointing out the deeper fishing holes in the lake, the morphologic data derived from this part of the assessment can be valuable to overall management of the lake vegetation as well as providing flood storage data for flood models. Table 1 provides the lake's morphologic parameters in various units.

Table 1. Lake Area Depth and Volume

Parameter	Feet	Meters	Acres	Gallons
Surface Area (sq)	1,167,596.24	108,473.24	26.09	
Mean Depth	12.23			
Maximum Depth	24.64			
Volume (cubic)	13,372,337.57	378,662.43		100,032,724.93
Gage Reading (feet above datum)	44.58			

Figure 2. Contour map for Lake George. The lake was mapped during the 2006 lake assessment project. A differential global positioning system and fathometer combination instrument was used to obtain simultaneous horizontal and vertical measurements



Section 2: Lake Ecology (vegetation)

The lake's apparent vegetative cover and shoreline detail are evaluated using the aerial shown in Figure 3 and by use of GPS. Submerged vegetation is determined from evenly spaced contours sampled using a Lowrance 26c HD, combined DGPS/fathometer described earlier. Ten vegetation assessment sites were used for Lake George (Figure 3) as dictated by the *Lake Assessment Protocol* (copy available on request) for a lake of this size. The site positions are set using a DGPS and then loaded into a GIS mapping program (ArcGIS) for display. Each site is field sampled in the three primary vegetative zones (emergent, submerged and floating). The latest aerials (2005, 6 inch resolution, SWFWMD aerials) are used to provide shore details (docks, structures, vegetation zones) and to calculate the extent of surface vegetation coverage. The primary indices of submerged vegetation cover and biomass for the lake, percent area coverage (PAC) and percent volume infestation (PVI), are determined by transiting the lake by boat and employing a fathometer to collect "hard and soft return" data. These data are later analyzed for presence and absence of vegetation and to determine the height of vegetation if present. The PAC index is determined from the presence and absence analysis of 100 sites in the lake and the PVI index is determined by measuring the difference between hard returns (lake bottom) and soft returns (top of vegetation) for sites (within the 100 analyzed sites) where plants are determined present.

The data collected during the site vegetation sampling include vegetation type, exotic vegetation, predominant plant species and submerged vegetation biomass. The total number of species from all sites is used to approximate the total diversity of aquatic plants and the total non-native plants on the lake (Table 2). The Watershed value in Table 2 only includes lakes sampled during the lake assessment project begun in May of 2006. These data will change as additional lakes are sampled. Tables 3 through 5 detail the results from the 2006 aquatic plant assessment for you lake. These data are determined from the 10 sites used for intensive vegetation surveys. The tables are divided into Floating Leaf, Emergent and Submerged plants and contain the plant code, species, common name and presence (1) or absence (blank) of species and the calculated percent occurrence (number sites species is found/number of sites) and type of plant (Native, Non-Native, Invasive, Pest). In the "Type" category, the term invasive indicates the plant is commonly considered invasive in this region of Florida and the term "Pest" indicates that the plant has a greater than 55% occurrence in your lake and is also considered a problem plant for this region of Florida, or in a non-native invasive that is or has the potential to be a problem plant in your lake and has at least 40% occurrence. These two terms are somewhat subjective; however, they are provided to give lake property owners some guidance in the management of plants on their property. Please remember that to remove or control plants in a wetland (lake shoreline) in Hillsborough County the property owner must secure an Application To Perform Miscellaneous Activities In Wetlands (http://www.epchc.org/forms_documents.htm) permit from the Environmental Protection Commission of Hillsborough and for management of in-lake vegetation outside the wetland fringe (for lakes with an area greater than 10 acres), the property owner must secure a Florida Department of Environmental Protection permit (http://www.dep.state.fl.us/lands/invaspec/).

Table 2 Total diversity, Total Non-Native, and number of EPPC pest plants

Parameter	Lake	Watershed
Total Plant Diversity (# of Taxa)	54	98
Total Non-Native Plants	9	17
Total Pest Plant Species	6	11

Figure 3. 2005 six inch resolution aerial and vegetation assessment sites on Lake George.

Table 3. List of Floating Leaf Zone Aquatic Plants Found in Lake George.

Code	Plant Species	Common Name	1	2	3	4	5	6	7	8	9	10	% Occurrence	Native (N), Non-Native (NN), Invasive (I), Pest (P)
HYE	*Hydrocotyl umbellata*	Manyflower Marshpennywort, Water Pennywort		1	1		1	1	1	1	1	1	80%	**Native**
NLM	*Nuphar lutea var. advena*	Spatterdock, Yellow Pondlily		1	1								20%	**Native**
NNA	*Nymphoides aquatica*	Banana Lily, Big Floatingheart	1	1									20%	**Native**
LEN	*Lemna spp.*	Common Duckweed			1								10%	**Native**

Table 4. List of Emergent Zone Aquatic Plants Found in Lake George.

Code	Plant Species	Common Name	1	2	3	4	5	6	7	8	9	10	% Occurrence	Native (N), Non-Native (NN), Invasive (I), Pest (P)
MEL	*Melaleuca quinquenervia*	Punk Tree, Melaleuca	1	1	1	1	1	1	1	1	1	1	100%	**NN-I-P**
TYP	*Typha spp.*	Cattails	1	1	1	1	1		1	1	1	1	90%	**N-I-P**
BMI	*Bacopa monnieri*	Common Bacopa, Herb-Of-Grace			1		1	1	1	1	1	1	70%	**Native**
COM	*Commelina spp.*	Dayflower		1			1	1	1	1	1	1	70%	**Native**
LOP	*Ludwigia spp.*	Water Primroses, Primrosewillow	1	1		1		1	1	1		1	70%	**Native**
PRS	*Panicum repens*	Torpedo Grass	1	1			1	1	1			1	60%	**NN-I-P**
EBI	*Eleocharis baldwinii*	Baldwin's Spikerush, Roadgrass		1		1		1	1	1	1		60%	**Native**
PAN	*Panicum spp.*	Panic grasses		1	1	1				1	1	1	60%	**Native**
PNA	*Phyla nodiflora*	Frog-fruit, Carpetweed, Turkey Tangle Fogfruit		1			1		1	1	1	1	60%	**Native**
SAL	*Salix spp.*	Willow		1			1	1	1			1	50%	**Native**
CEA	*Colocasia esculenta*	Wild Taro, Dasheen, Coco Yam		1		1	1	1		1			50%	**NN-I-P**
TAS	*Taxodium ascendens*	Pond Cypress	1	1			1			1	1		50%	**Native**
APS	*Alternanthera philoxeroides*	Alligator Weed					1	1	1	1			40%	**NN-I-P**
DVA	*Diodia virginiana*	Buttonweed			1					1	1	1	40%	**Native**
STS	*Schinus terebinthifolius*	Brazilian Pepper		1			1	1					30%	**NN-I**
CYO	*Cyperus odoratus*	Fragrant Flatsedge						1			1	1	30%	**Native**
DMI	*Desmodium incanum*	Creeping Beggarweed						1			1	1	30%	**Native**
EAA	*Eclipta alba (prostrata)*	False Daisy, Yerba De Tajo		1				1				1	30%	**Native**
FSR	*Fuirena scirpoidea*	Southern Umbrellasedge, Rush Fuirena						1		1		1	30%	**Native**
MSS	*Mikania scandens*	Climbing Hempvine					1	1				1	30%	**Native**
SCS	*Scirpus cubensis*	Burhead Sedge,Cuban Scirpus		1				1	1				30%	**Native**
WTA	*Sphagneticola (Wedelia) trilobata*	Creeping Oxeye					1					1	20%	**NN-I**
LRS	*Ludwigia repens*	Creeping Primrosewillow, Red Ludwigia							1	1			20%	**Native**
OCA	*Osmunda cinnamomea*	Cinnamon Fern				1		1					20%	**Native**

POL	*Polygonum spp.*	Smartweed, Knotweed			1		1						20%	**Native**
RHY	*Rhynchospora spp.*	Beaksedge						1		1			20%	**Native**
CLA	*Casuarina equisetifolia*	Australian Pine										1	10%	**NN-I**
URL	*Urena lobata*	Caesar's Weed						1					10%	**NN-I**
ACE	*Acer rubrum var. trilobum*	Southern Red Maple					1						10%	**Native**
BLS	*Blechnum serrulatum*	Swamp Fern		1									10%	**Native**
CAA	*Centella asiatica*	Asian Pennywort, Coinwort, Spadeleaf										1	10%	**Native**
CYP	*Cyperus spp.*	Sedge										1	10%	**Native**
ELE	*Eleocharis spp.*	Roadgrass, Spikerushes		1									10%	**Native**
JES	*Juncus effusus var solutus*	Soft Rush		1									10%	**Native**
NSS	*Nephrolepsis spp.*	Sword fern				1							10%	**Native**
PSQ	*Parthenocissus quinquefolia*	Woodbine	1										10%	**Native**
PSU	*Phyllanthus urinaria*	Leaf Flower		1									10%	**Native**
PIN	*Pinus spp.*	Pine Tree		1									10%	**Native**
QPS	*Quercus phellos*	Willow Oak					1						10%	**Native**
SAM	*Sambucus canadensis*	Elderberry		1									10%	**Native**
UNK	*UNKNOWN SPP*	Unidentified Plant Species				1							10%	**Native**

Figure 4. Cattails (*Typha spp.)* are a common native species on Lake George, however this species can become a dominant species and crowd out other natives.

Figure 5. Melaleuca trees (*Melaleuca quinquenervia*) is a non-native invasive species which can form extensive stands along shorelines as it has in this example from Lake George.

Table 5. List of Submerged Zone Aquatic Plants Found in Lake Carroll.

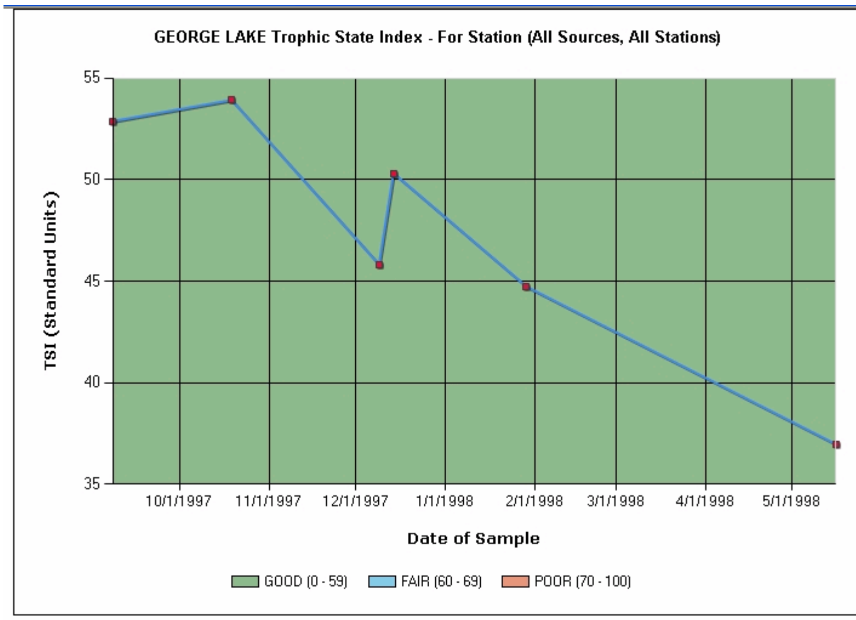
Code	Plant Species	Common Name	1	2	3	4	5	6	7	8	9	10	% Occurrence	Native (N), Non-Native (NN), Invasive (I), Pest (P)
NGS	*Najas guadelupensis*	Southern Waternymph	1	1	1	1	1	1	1	1	1	1	100%	**Native**
PIS	*Potamogeton illinoesis*	Pond Weed	1	1	1	1	1	1	1	1	1	1	100%	**N-I-P**
ALG	*Algal Spp.*	Algal Mats, Floating	1	1	1	1	1	1	1	1			80%	**Native**
POT	*Potamogeton spp.*	Pond Weed	1	1		1	1	1			1	1	70%	**Native**
VAA	*Vallisneria americana*	Tapegrass			1	1		1	1	1		1	60%	**Native**
CHA	*Chara spp*.	Muskgrass			1	1			1			1	40%	**Native**
NIT	*Nitella spp.*	Nitella	1		1			1					30%	**NN-I**
MGM	*Micranthemum glomeratum*	Manatee Mudflower, Baby's Tears					1	1					20%	**Native**
SPY	*Spirogyra spp.*	Filamentous algae1 mats			1								10%	**Native**

Figure 6. Pond Weed (*Potamogeton illinoesis*)

Figure 7. Floating Algal mats in Lake George.

Section 3: Lake Water Chemistry

A critical element in any lake assessment is the long-term water chemistry data set. The primary source of water quality trend data for Florida Lakes, is the Florida LAKEWATCH volunteer and the Florida LAKEWATCH water chemistry laboratory. Hillsborough County is fortunate to have a large cadre of volunteers who have collected lake water samples for a significant time period. Unfortunately, Lake George has not had an active volunteer for nine years. The last available trend data is shown in Figure 8. Additional data, when available, is also included on the Water Atlas. Figure 9 shows the USGS NWIS chlorophyll (a) value for July 2000 plotted with the earlier LAKEWATCH data. The NWIS chlorophyll single point value, although more recent, does not seem to indicate an actual trend toward higher nutrient levels (as indicated by chlorophyll concentration) and may represent an anomaly in the data. The June 2006 lake assessment water quality data indicates that a chlorophyll (a) level between 10-11 µg/L and a TSI of between 45-46. These values are comparable to the earlier LAKEWATCH data and other water quality samples collected by the Hillsborough County Stormwater Section. Lake George is a clear water lake and as such it must maintain a TSI of below 40 to not be considered impaired by the State of Florida guidelines[iv]. Although, there may not be adequate data to indicate impairment, the existing water quality data indicates that this lake may be impaired based on FDEP guidelines. Hillsborough County has added Lake George to lakes that it samples as part of it's Stormwater sampling effort. These data will be available in 2007 on the Hillsborough Water Atlas.



Note: The graph above includes benchmarks for using verbal descriptors of "good", "fair" and "poor". The verbal descriptors for these benchmarks are based on an early determination by stakeholders of the generally acceptable and understood terms for describing the state of lakes. The same benchmarks are used for nutrient graphs (Nitrogen and Phosphorus), chlorophyll graphs and trophic state index (TSI) graphs. The TSI is a calculated index of lake condition based on nutrient and chlorophyll (a) concentrations (please see "Learn more about Trophic State Index"). The benchmarks are established based on the TSI range that relates to a specific descriptor. The source for the TSI concentration relationships is the Florida Water Quality Assessment, 1996, 305(b) (Table 2-8). For many lakes there is more than a single source of water quality data. You have the option with the "Select Data Source" drop down to select any available data source and create the graph using that source or you may select "All" to graph all available data. The graph header will also change to reflect the source used.

Figure 8. Recent Trophic State Index graph from Hillsborough Watershed Atlas.

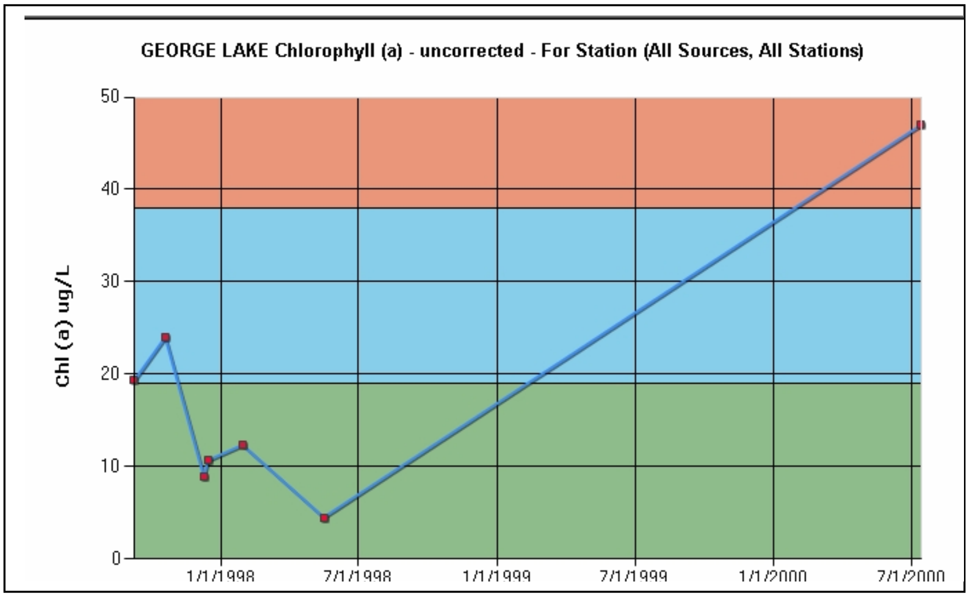


Figure 9 Lake George Chlorophyll (a) values from LAKEWATCH (uncorrected_1997-98) and USGS (NWIS) (corrected_2000)

Table 6a contains the summary water quality data and index values and adjusted values calculated from these data. The total phosphorus (TP), total nitrogen (TN) and chlorophyll (a) water chemistry sample data are the results of chemical analysis of samples taken during the assessment and analyzed by the Hillsborough County Environmental Protection Commission laboratory. These data compare with the mean data from the LAKEWATCH data set as discussed earlier.

Table6a. Water Quality Parameters.

Summary Table for Water Quality		
Parameter	**Value**	**Comment**
TP ug/L	31.00	
TN mg/L	0.50	
Chla ug/L	11.20	
Chla TSI	51.59	
TP TSI	57.24	
TN TSI	44.48	
Secchi Disk (SD)	6' 11"	
TSI	46.38	Balanced
PAC	63%	
PVI	33%	
Adj TP ug/L	4.89	
Adj TN mg/L	0.07	
Adj Chla ug/L	0.01	
Adj TSI	48.12	With added Nutrient

Table 6B contains the field data taken in the center of the lake using a YSI Corporation – 6000 multi-probe which has the ability to directly measure the temperature, pH, dissolve oxygen (DO), percent DO (calculated from DO, temperature and conductivity) and Turbidity. These data are listed for three levels in the lake and twice for the surface measurement. The duplicate surface measurement was taken as a quality assurance check on measured data. The profile based on these data indicates a rather productive, well mixed lake. Lake George has a significant amount of submerged vegetation with a 63% coverage of submerged vegetation composing about 33% of the lake volume. Submerged vegetation may be regulating DO, pH and ORP.

Table 6b. Field Observed Values (YSI).

Sample Location	Time	Temp (oC)	Conduct-ivity (mS/cm3)	Dissolved Oxygen (%)	DO (mg/L)	pH (PH)	ORP (ORP)	Tubidity (NTU)	Secchi Depth
Surface	13:07	29.08	0.239	105.7	8.12	7.99	302.1	-0.9	
Mid	13:07	29.07	0.239	105.1	8.08	8.04	294.9	-0.8	
Bottom	13:07	29.01	0.238	108.9	8.04	8.2	285.5	-0.8	
Surface	13:07	29.04	0.239	104.2	8.2	8.07	280	-0.8	
Mean		**29.05**	**0.23875**	**117.225**	**8.11**	**8.075**	**290.625**	**-0.825**	**6' 11"**

Table 6a also provides data derived from the vegetation assessment which is used to determine an adjusted TSI. This is accomplished by calculating the amount of phosphorus that could be released by existing submerged vegetation if this vegetation were treated with an herbicide or managed by the addition of Triploid Grass Carp (*Ctenopharyngodon idella*). While it would not be expected that all the vegetation would be turned into available phosphorus by these management methods, the data is useful when planning various management activities. Approximately 63% of the lake has submerged vegetation present and this vegetation represents about 33% of the available lake volume. The vegetation holds enough nutrients to add about 4.9 μg/L of total phosphorus and 0.07 mg/L total nitrogen to the water column. Because the growth of algae in the water is regulated by the availability of nitrogen and phosphorus (the lake is nutrient balanced), the release of this phosphorus and nitrogen would stimulate algal growth. These changes in the water chemistry and biology would be indicated by an increased TSI from about 46 to about 48. The lake water clarity which is indicated by the Secchi Disk (SD) value at 6 feet and eleven inches would be reduced under these conditions.

Section 4: Conclusion

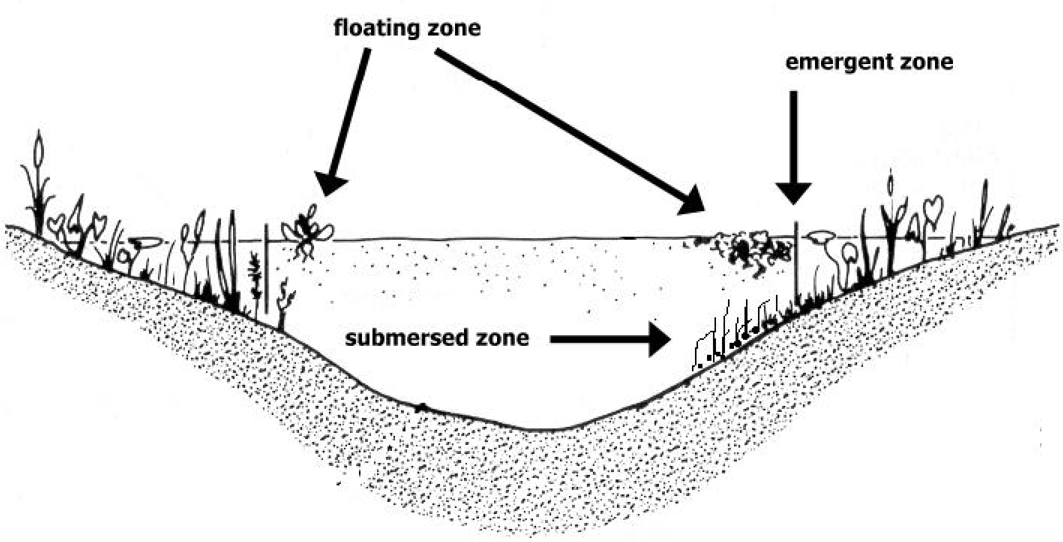
Lake George is a small sized (26 acre) lake that would be considered in the mesotrophic (good) category of lakes based on water chemistry. About 63% of the open water areas contain submerged vegetation and this vegetation helps to maintain the nutrient balance in the lake as well as provide good fish habitat. The lake has many open water areas that support various types of recreation and has a good diversity of plant species. The primary pest plants in the lake include Punk tree (*Melaleuca*), Cattails (*Typha spp*.), Torpedo grass (*Pancium repens*), Wild taro, Pond Weed (*Potamogeton illinoesis*) and Water pennywort (*Hydrococtyl umbellate*). For more information and recent updates please see the Hillsborough Watershed Atlas (water atlas) website at: http://www.hillsborough.wateratlas.usf.edu/lake/waterquality.asp?wbodyid=5180&wbodyatlas=lake

i"Trophic" means "relating to nutrition." The Trophic State Index (TSI) takes into account chlorophyll, nitrogen, and phosphorus, which are nutrients required by plant life. For more information please see *learn more* at: http://www.hillsborough.wateratlas.usf.edu/lake/default.asp?wbodyid=5168&wbodyatlas=lake

ii A bathymetric map is a map that accurately depicts all of the various depths of a water body. An accurate bathymetric map is important for effective herbicide application and can be an important tool when deciding which form of management is most appropriate for a water body. Lake volumes, hydrolic retention time and carrying capacity are important parts of lake management that require the use of a bathymetric map.

iii WAAS is a form of differential GPS (DGPS) where data from 25 ground reference stations located in the United States receive GPS signals form GPS satellites in view and retransmit these data to a master control site and then to geostationary satellites. The geostationary satellites broadcast the information to all WAAS-capable GPS receivers. The receiver decodes the signal to provide real time correction of raw GPS satellite signals also received by the unit. WAAS enabled GPS is not as accurate as standard DGPS which employs close by ground stations for correction, however; it was shown to be a good substitute when used for this type of mapping application. Data comparisons were conducted with both types of DGPS employed simultaneously and the positional difference was determined to be well within the tolerance established for the project.

iv The three primary aquatic vegetation zones are shown below:



[v] A lake is impaired if " (2) For lakes with a mean color less than or equal to 40 platinum cobalt units, the annual mean TSI for the lake exceeds 40, unless paleolimnological information indicates the lake was naturally greater than 40, or
For any lake, data indicate that annual mean TSIs have increased over the assessment period, as indicated by a positive slope in the means plotted versus time, or the annual mean TSI has increased by more than10 units over historical values. When evaluating the slope of mean TSIs over time, the Department shall use a Mann's one-sided, upper-tail test for trend, as described in Nonparametric Statistical Methods by M. Hollander and D. Wolfe (1999 ed.), pages 376 and 724 (which are incorporated by reference), with a 95% confidence level."
Excerpt from Impaired Water Rule (IWR). Please see:
http://www.dep.state.fl.us/water/tmdl/docs/AmendedIWR.pdf